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Morphological investigation of *Mesocestoides* (Cestoda, Mesocestoididae) species parasitizing *Vulpes vulpes* in Hungary

by
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Abstract: Parasites of red foxes (*Vulpes vulpes*) were examined from different territories of Hungary in order to clarify morphological differentiation and taxonomic situation in the tapeworm genus *Mesocestoides* Vaillant, 1863. Two species of *Mesocestoides* were found, identification for the species recovered from red foxes in Hungary is the following: *Mesocestoides litteratus* (Batsch, 1786): cirrus pouch elongated, 48 to 96 µm (mean 70) in width, located anteriorly, near middle of segment, maximum diameter of testes 14 to 76 µm (mean 42); *Mesocestoides lineatus* (Goeze, 1782) Railliet, 1893: cirrus pouch oval, 118 to 244 µm (mean 165) in width, situated anteriorly, near middle of segment, maximum diameter of testes 56 to 213 µm (mean 115).
Keywords: Cestoda, Mesocestoididae, *Mesocestoides lineatus*, *Mesocestoides litteratus*, morphology, host species: *Vulpes vulpes,* Hungary

Introduction

Members of the family Mesocestoididae Fuhrmann, 1907, are placed in two genera, *Mesocestoides* Vaillant, 1863 and *Mesogyna* Voge, 1952, however, the anatomy of the second one has not been fully described (Rausch 1994). *Mesocestoides* is the most common tapeworm in European foxes, though it seems to be rare on the British Isles (Loos-Frank & Zeyhle 1982). The taxonomy of *Mesocestoides* is also complicated as a consequence of the considerable morphological variation of the species. Goeze (1782) described two species from mammals: *Taenia cateniformis* and its variation as "variety" of *Taenia cateniformis*, which was designated by Batsch (1786) as *Taenia litterata.* These both belong to the genus *Mesocestoides.* The second species was *Taenia lineata,* which is also related to a species belonging to the genus *Mesocestoides*. Zeder (1800, 1803) described two true *Mesocestoides* tapeworms *Alyselminthus litteratus* and *Halysis litterata.* Zschokke (1885, 1889) published a detailed description about *Taenia litterata* Batsch, 1786. *Mesocestoides canislagopodis* (Rudolphi, 1810) published by Viborg (1795), called as *Taenia canis lagopodis* Rudolphi, 1810 was found by Krabbe (1865) in dogs and cats, may be the synonym of *M. lineatus* or *M. litteratus* or identical with *M. kirbyi* described by Chandler (1944). Witenberg (1934) regarded *M. litteratus* (Batsch, 1786), *M. caestus* Cameron, 1925 as a synonym of *M. lineatus* and incorrectly distinguished three forms of *M. lineatus*, such as *M. lineatus* forma *lineata, M. lineatus* forma *literrata, M. lineatus* forma *caesta. Mesocestoides petrowi* described by Sadychov (1971) seems to be a synonym of *Mesocestoides litteratus* (Batsch, 1786). Loos-Frank (1980) proposed a new name *M. leptothylacus* with type designation for

M. lineatus, which is common in red foxes (*Vulpes vulpes*), but it has not been widely accepted. Priemer (1983) identified two species of *Mesocestoides, M. lineatus* and *M. litteratus* from red foxes in Germany (formerly G.D.R.) and discussed the nomenclature problems of the genus *Mesocestoides* in Central Europe. Loos-Frank (1990) also observed two different groups of *Mesocestoides* from *Vulpes vulpes* in Israel, one of them was identified as *M. leptothylacus* (= *M. lineatus*). At the same time, a parasite of arctic foxes (*Alopex lagopus*) has been recovered by Loos-Frank *et al.* (1992) and redescribed as *Mesocestoides canislagopodis* (Rudolphi, 1810) (Krabbe, 1865). *Mesocestoides canislagopodis* (Rudolphi, 1810) (Krabbe, 1865) sensu Loos-Frank *et al.* 1992 seems to be a good *Mesocestoides* species, but the tetrathyridia of it have not yet been found.

Chertkova & Kosupko (1975, 1978) discriminated 12 species of *Mesocestoides*, such as *M. petrowi, M. lineatus, M. mesorchis, M.beringi, M. zacharovae, M. erschovi, M. litteratus, M. kirbyi, M. caestus, M. didelphus, M. charadrii, M. perlatus*. On the other hand, Schmidt (1986) listed 26 *Mesocestoides* species parasitizing birds and mammals. Anyway, only a few species of the genus *Mesocestoides* can be reliably distinguished (Rausch 1994).

Voge (1955) and Chertkova *et al.* (1975) published for the first time the form of the cirrus and mode of its rolling-up, the form of the cirrus pouch and the number and distribution of testes as important differentiating morphological characters for the identification of *Mesocestoides* species, that were applied later by others, too.

The aim of our study was to examine morphological characteristics of *Mesocestoides* species parasitizing red foxes (*Vulpes vulpes*) in Hungary and give an identification key for distinguishing of different species from each other.

Materials and methods

This study is based on specimens recovered from red foxes (*Vulpes vulpes*), hunted in different parts of Hungary (Zemplén Mountain, Budapest, Budakeszi, Telki, Újszász, Makó, Hollád, Babat, Perbál) between the years 1973 and 1993. The cestodes were fixed in hot formaline and stored in 5 % formaline. The specimens were stained by iron-carmine after Georgiev *et al.* (1986) or haematoxiline and mounted in Canada balsam. The whole-mount slides (HNHM-15256/1-8, HNHM-13129/1-12, HNHM-6837/2, HNHM-4635/1-4, HNHM-5014/1-11, HNHM-7819/1, 7846/1-2, HNHM-6226/1,4,5,7,8, HNHM-7817/1-3,6,7-10, HNHM-5312/1,3-8, HNHM-7839/1-4, HNHM-6981/5) are deposited in the Parasitological Collection of the Hungarian Natural History Museum.

Cestodes were photographed using a special image acquisition system developed in Parasitological Collection. An Olympus BH-2 microscope was connected with an IBM compatible PC. A grey scale Panasonic video camera (420 lines) and a high-resolution video digitising card (760 lines) were used with the modified version (Gubányi unpublished) of IMAGOES software (Demeter *et al.* 1996).

Distance measurements calculated from pseudo landmark points by the means of the Euclidean Distances Function were as follows: length of cirrus pouch (CD1-2), width of cirrus pouch (CD3-4), anterior width of immature segment (AD1-2), posterior width of immature segment (AD3-4), length of immature segment (AD5-6), anterior width of mature segment (BD1-2), posterior width of mature segment (BD3-4), length of mature segment (BD5-6), length of left masses of vitelline gland (VD1-2), width of left masses of vitelline gland (VD3-4), length of right masses of vitelline gland (VD5-6),width of right masses of vitelline gland (VD7-8), anterior width of segment containing uterus (UD1-2), posterior width of segment containing uterus (UD3-4), length of segment on left side containing uterus

(UD1-3), length of segment on right side containing uterus (UD2-4), diameter of testes (TD1-2), length of ovary (OD1-2), width of ovary (OD3-4), anterior width of gravid segment (DD1-2), posterior width of gravid segment (DD3-4). length of gravid segment on left side (DD1-3), length of gravid segment on right side (DD2-4), maximum diameter of onchosphere (DO1-2), length of paruterine organ (PD1-2), width of paruterine organ (PD3-4).

The measurements were analysed by descriptive statistics using Statistica 5.0 program package and are given in micrometres, except for strobila length, which is given in millimetre.

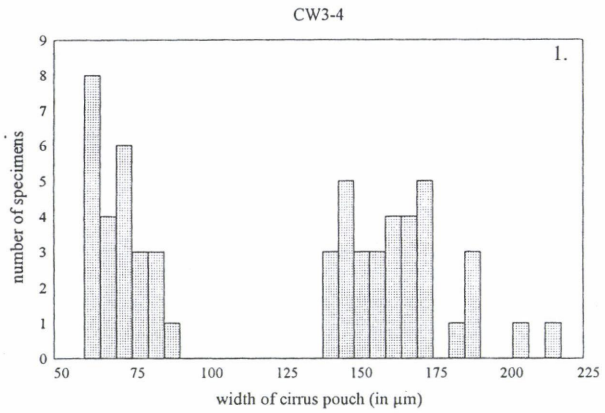
Results and discussion

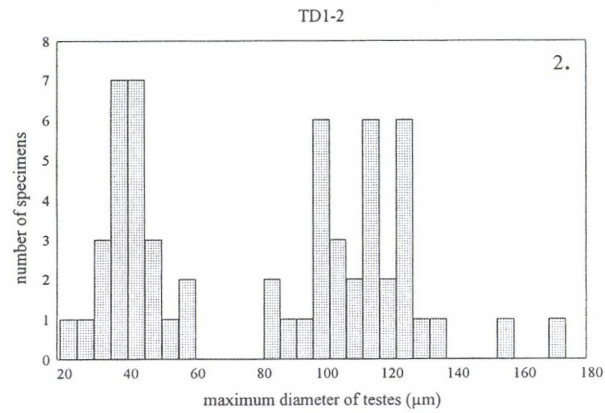
Two main groups of distance measurements can be distinguished. More than 50 percent of the investigated measurements (CD1-2, AD3-4, AD5-6, BD1-2, BD3-4, BD5-6, VD1-2, VD3-4, UD1-2, UD3-4, OD1-2, OD3-4, DD1-2, DD3-4, DD1-3, DD2-4, DO1-2, PD1-2, PD3-4) did not show any discriminating characteristic. As shown on Fig. 1, frequency distribution of CD3-4, TD1-2, VD5-6, AD1-2, UD1-3, UD2-4 can be characterised by two well separated peaks. After dividing the samples into two groups using the width of cirrus pouch (CD3-4) and the diameter of testes (TD1-2) a significant difference ($P<0.05$) has been found between them. The length and width of paruterine organ of two specimens show extremely small values compared to the other samples. Extreme values were also found for the length of mature segment (128 and 1233, respectively) among the specimens.

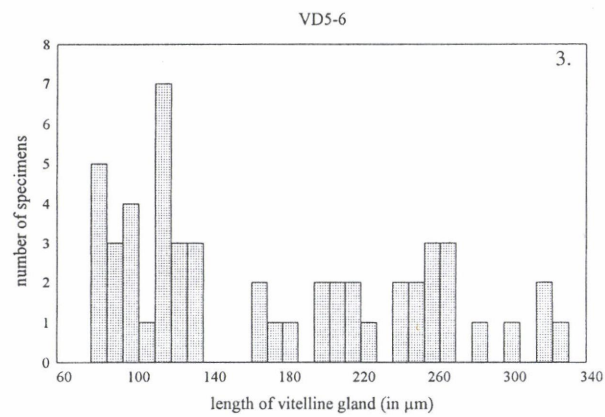
Mesocestoides lineatus (Goeze, 1782) Railliet, 1893
(Figs 7, 9, 11, 13)

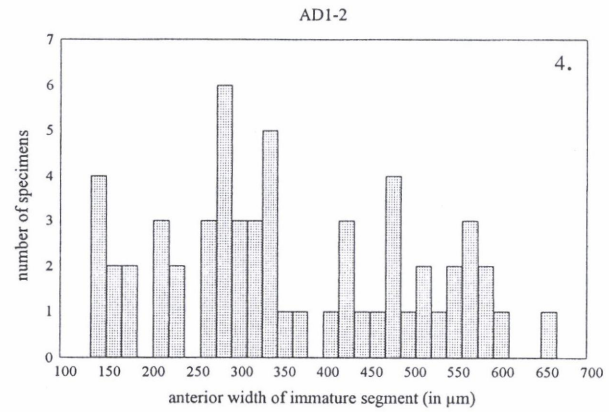
(syn. *Taenia lineata* Goeze, 1782, *Taenia vulpina* Schrank, 1788, *Taenia cataeniformisvulpes* Gmelin, 1790. *T. pseudocucumerina* Railliet, 1863, *Monoderidum urticulifera* Walter, 1866, *Ptychophysa lineata* (Goeze, 1882), Hamann, 1885, *Halisis lineata* Zeder, 1803, *Mesocestoides angustatus* (Rudolphi, 1819), *M. litteratus* (Batsch, 1786) sensu Mueller, 1927, *M. variabilis* Mueller, 1927, nec Byrd & Ward, 1943, *M. tenuis* Meggitt, 1931, *M. carnivoricolus* Grundmann, 1956, *M. paucitesticulatus* Sawada & Kugi, 1973, *M. leptothylacus* Loos-Frank, 1980)

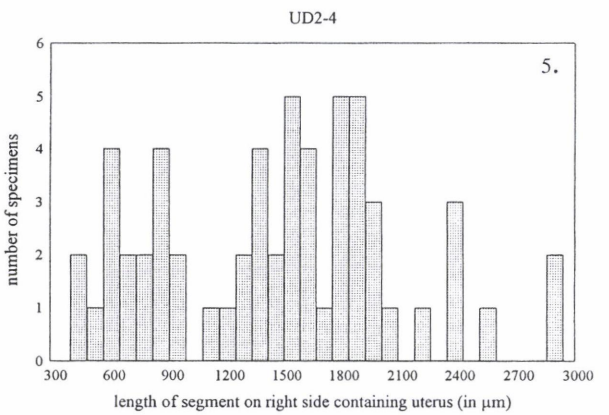
Description: Strobila 58 to 239 mm long, containing 74 to 473 segments, anterior width 265 to 700 (mean = 464), posterior width 318 to 871 (mean 567), length 141 to 878 (mean 354) in immature segments; anterior width 252 to 792 (mean 501), posterior width 383 to 1029 (mean 624) and length 148 to 980 (mean 452) in mature segments; anterior width 380 to 1528 (mean 692), posterior width 487 to 1966 (mean 851), length on left side 345 to 3011 (mean 1213) and length on right side 366 to 3033 (mean 1226) in segments containing uterus; anterior width 206 to 1163 (mean 559), posterior width 323 to 1467 (mean 713), length on left side 351 to 3032 (mean 1457) and length on right side 392 to 3019 (mean 1475) in gravid segments. Scolex 403 (196-957) by 416 (117-641). Suckers arranged in two pairs, 201 (97-314) by 162 (79-232). Neck short, testes numerous, maximum diameter 56 to 213 (mean 115), surrounding the genital glands. Cirrus pouch oval, 157 to 570 (mean 305) in length and 118 to 244 (mean 165) in width, situated anteriorly, near middle of segment. Ovaries, consisting of two lobes, situated posteriorly, 106 (60 to 159) by 144 (95 to 234) Vitelline glands ovoid in dorsoventral view, 228 (101 to 393) by 148 (60 to 259). Paruterine organ present, more or less spherical and develops into caudal appendage. Size of paruterine organ 838 (260 to 1274) by 670 (182 to 952). Eggs spherical, containing ovoid onchosphere, 96 to 241 (mean 159) in diameter.

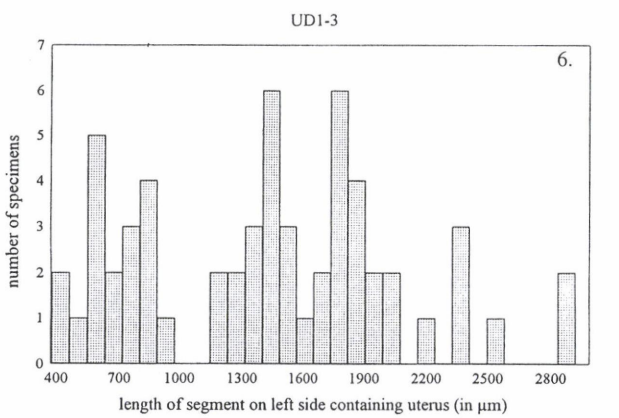

CW3-4
1.
number of specimens
0
1
2
3
4
5
6
7
8
9
50
75
100
125
150
175
200
225
width of cirrus pouch (in µm)


TD1-2
2.
number of specimens
0
1
2
3
4
5
6
7
8
20
40
60
80
100
120
140
160
180
maximum diameter of testes (µm)


VD5-6
3.
number of specimens
0
1
2
3
4
5
6
7
8
60
100
140
180
220
260
300
340
length of vitelline gland (in µm)







Figs 1–6. Freqency distribution of different morphological characters. 1 = width of cirrus pouch; 2 = maximum diameter of testes; 3 = length of vitelline gland; 4 = anterior width of immature segment; 5 = length of segment on right side containing uterus; 6 = length of segment on left side containing uterus

Mesocestoides litteratus (Batsch, 1786)
(Figs 8, 10, 12, 14)

(syn. *Taenia literrata* Batsch, 1786, *M. canislagopodis* (Rudolphi, 1810) sensu Zschokke, 1889, *M. lineatus* f. *litterata* Witenberg, 1934)

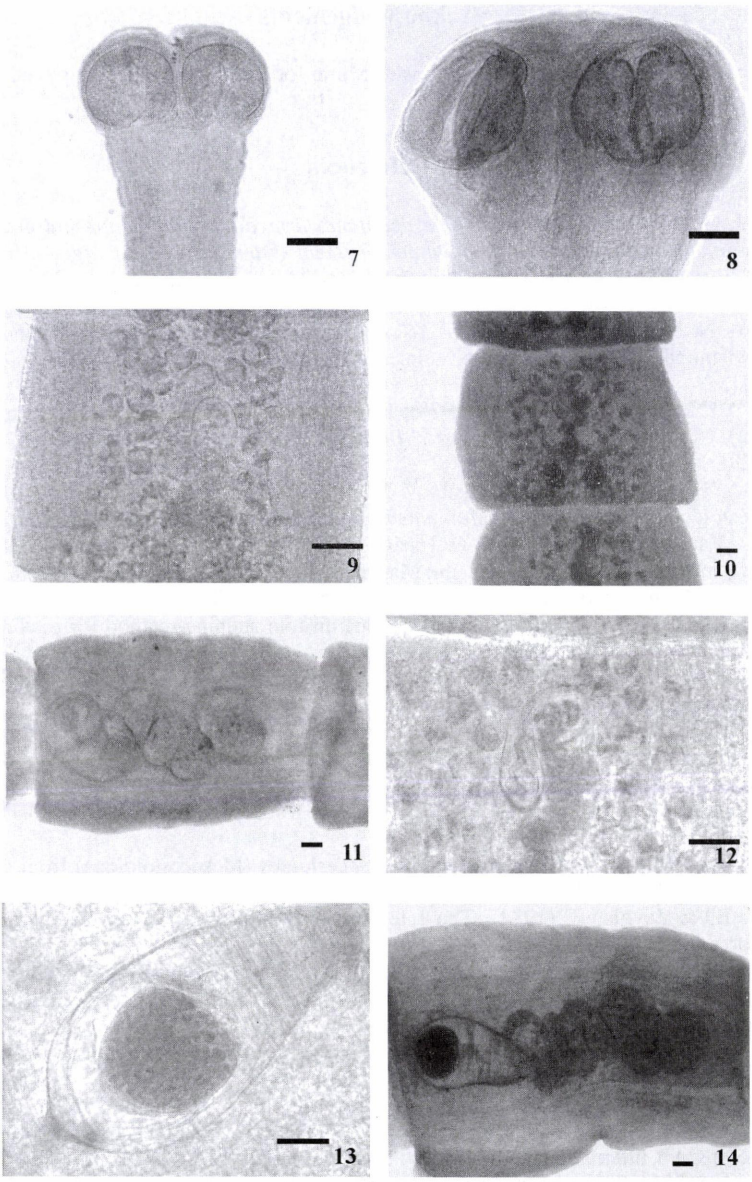
Description: Strobila 57 to 568 mm long, containing 95 to 474 segments; anterior width 97 to 414 (mean 247), posterior width 147 to 588 (mean 307) and length 89 to 579 (mean 223) in immature segments; anterior width 103 to 443 (mean 272), posterior width 150 to 531 (mean 342) and length 126 to 392 (mean 275) in mature segments; anterior width 87 to 1453 (mean 780), posterior width 116 to 1886 (mean 1067), length on left side 145 to 3020 (mean 1766) and length on right side 143 to 3044 (mean 1774) in segments containing uterus; anterior width 220 to 1452 (mean 634), posterior width 371 to 1726 (mean 871), length on left side 943 to 3024 (mean 1980) and length on right side 980 to 3048 (mean 1990) in gravid segments. Scolex 589 (443-806) by 589 (353-736), unarmed. Suckers arranged in two pairs, 242 (185-344) by 206 (130-273). Neck slender and short. testes numerous, maximum diameter 14 to 76 (mean 42), surrounding the genital glands. Cirrus pouch elongated, 74 to 278 (mean 170) in length and 48 to 96 (mean 70) in width, located anteriorly, near middle of segment. Ovaries, consisting of two lobes, situated posteriorly, 152 (73 to 208) by 186 (98 to 288). Vitelline glands ovoid in dorsoventral view, 110 (56 to 160) by 65 (28 to 116). Paruterine organ present, more or less spherical and develops into caudal appendage. Size of paruterine organ 982 (94 to 1432) by 705 (56 to 973). Eggs spherical, containing ovoid onchosphere, 16 to 304 (mean 164) in diameter.

Identification key for the species of the genus *Mesocestoides* Vaillant, 1863, recovered from red foxes (*Vulpes vulpes*) in Hungary

1a. Cirrus pouch elongated, 48 to 96 (mean 70) in width, located anteriorly, near middle of segment, maximum diameter of testes 14 to 76 (mean 42)
. . . . . *Mesocestoides litteratus* (Batsch, 1786)

2a. Cirrus pouch oval, 118 to 244 (mean 165) in width, situated anteriorly, near middle of segment, maximum diameter of testes 56 to 213 (mean 115)
. . . . . *Mesocestoides lineatus* (Goeze, 1782) Railliet, 1893

Hitherto the most important features for discrimination of species of the genus *Mesocestoides* proved to be the shape of the cirrus and the cirrus pouch. According to our results besides the above-mentioned facts the shape of the testes, especially the maximum diameter of the testes can serve to distinguish the *Mesocestoides* species from each other, recovered from red fox. Considerable inter- and intraspecific morphological variation has been found in other characters CD1-2, AD3-4, AD5-6, BD1-2, BD3-4, BD5-6, VD1-2, VD3-4, UD1-2, UD3-4, DD1-2, DD3-4, DD1-3, DD2-4, DO1-2, PD1-2, PD3-4, which can be explained by individual specific immune reaction, unique condition and feeding habit of host. Foxes feed on plants in spring and certain plants may decrease the prevalence of *Mesocestoides*. On the other hand, *Mesocestoides* exhibits a seasonal periodicity having lower prevalence in summer than winter (Loos-Frank & Zeyhle 1982). Consequently, our materials might contain tapeworms of different age and *Mesocestoides* can stay alive more or less during the lifetime of its host.



Figs 7–14. *Mesocestoides* species parasitizing *Vulpes vulpes* in Hungary. 7 = *M. lineatus* scolex; 8 = *M. litteratus* scolex; 9 = *M. lineatus* mature segment; 10 = *M. litteratus* mature segment; 11 = *M. lineatus* gravid segment; 12 = *M. litteratus* cirrus pouch; 13 = *M. lineatus* paruterine organ; 14 = *M. litteratus* paruterine organ (scale bar 100 μm)

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